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Designing a Fleet

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About the author

Andrew Watts joined the Royal New Zealand Navy in 1980 as a Midshipman in what was then the seaman specialisation. He qualified as Principal Warfare Officer in 1989, and commanded HMNZ Ships *Pukaki* (II), *Wellington*(F69), *Resolution* and *Te Mana*. He first retired from the Navy as a Captain in 2011, spending what he describes as an immensely rewarding three years in the private sector working for Opus International Consultants. He re-joined the Navy in 2014 at the request of the then Chief of Navy to take up an appointment as Director, Operation NEPTUNE, the Navy's year long programme of events to celebrate the 75th Anniversary of its founding in 1941. His final appointment was as Lead, Future Surface Combatant in Capability Branch, HQNZDF, and it was in this capacity that he formed the views on which this paper is based. He transferred from regular service to the standby Naval Reserve in January 2020. He is now employed by KPMG Saudi Arabia and the Levant as a Defence Consultant.

Andrew Watts at the change of Command ceremony on relinquishing Command of HMNZS *Te Mana.*

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Cover image: HMNZS TE KAHA (supplied by author).

Designing a Fleet

Andrew Watts[1]

Introduction

The Royal New Zealand Navy is facing an unprecedented period of transition. Most of the ships in our existing fleet will wear out over a very short time frame in the early 2030’s, and we are beginning the process of acquiring yet more diversity in capability with the Southern Ocean Patrol Vessel (SOPV)[2] and a new amphibious ship. We have an opportunity to put in place a coherent, affordable, and sustainable fleet should we choose to fully exploit new technologies and doctrines, but time frames are such that we must start thinking about them now. This paper describes the fleet re-capitalisation opportunity with a view to stimulating further discussion, particularly amongst naval practitioners, NZDF capability staffs across all domains, and the policy development, capability development, and capability delivery Ministry of Defence officials who will be confronted with the fleet re-capitalisation problem over the next two – three years.

Our dependence on sea borne trade is complete, but the freedom of the seas[3] on which our economic life depends is neither a permanent nor a natural state of affairs. Piracy still manifests itself wherever the means and the will to defend peaceful trade against it are absent. Drugs, weapons, and people are trafficked by sea in huge quantities with de-stabilising effects on fragile systems of governance. Some of the fundamental principles underpinning the Law of the Sea are being directly challenged by nation states – China’s actions in the South China Sea are by no means the only example. Challenges to the rule of law at sea may generally arise in areas remote from New Zealand, but every break down de-stabilises the rules-based order on which our security and prosperity depend. One of the enduring constants in New Zealand defence policy is that as a direct beneficiary of the rule of law at sea, we have a direct stake in the collective effort to protect it.

Coupled with this, our Exclusive Economic Zone is one of the largest in the world. The resources it contains must be protected, both for the good of our economy and for the preservation of the eco-systems on which future generations will depend. Our borders are protected by the thousands of miles of ocean that surround them, but this protection may not be permanent as threats mount and technologies develop. We have constitutional responsibilities for the defence of some of our Pacific partner nations, and familial ties with others which make their security interests inseparable from our own. We must be able to project and support our special and land forces when they are deployed. That these drivers for maritime defence capability exist is not contentious.

Without identifying specific levels of capability (and investment), this paper discusses strategies for addressing our maritime defence capability needs, and the opportunities which underpin those strategies.

Designing a Force Structure (Not Replacing Ships)

This paper is based on the premise that "like for like" replacement of the current fleet should not be the default force structure option. Fleet re-capitalisation must be based on a unified, top-down view of operational requirements, informed by technological and doctrinal opportunity and by affordability in acquisition and through life sustainment. We must design a fleet, not replace ships, and the very short time frame in which most of our ships wear out gives us an opportunity to do so.

Force Structure Transitions

In force structure terms, the RNZN is approaching what I would call its third transitional phase. Our first force structure was established immediately after the second world war, when a navy suited to New Zealand's needs had to be designed from scratch. The choices made were excellent – six nearly new Loch class frigates (the best Anti-Submarine Warfare (ASW) ships in the world at the time) were acquired from Britain, followed by two relatively modern light cruisers. Although these ships spent a high proportion of their service lives in reserve, this credible, balanced force gave government a range of options for contributing to the type of operation most likely at the time – large, allied coalitions based on operational frameworks provided by the US and Britain.

The first transition occurred when the war-built Loch class frigates and Improved Dido class cruisers ran out of service life in the early to mid-60's. The new generation of ASW frigates then being acquired by the Royal Navy (RN), Royal Australian Navy (RAN), and Royal Canadian Navy (RCN) offered an affordable means of contributing to wider allied efforts to balance Soviet naval expansion while capitalising on the expertise in frigate operations that had been built up since the second world war.[4] The Type 12 ASW frigates HMNZ Ships *Otago* and *Taranaki* were commissioned in the early 60's, followed by the Improved Type 12 (Leander class) HMNZS *Waikato* in 1966 and HMNZS *Canterbury* in 1971.[5] Two second-hand Leander class frigates were acquired from the Royal Navy in the early 80's to replace *Otago* and *Taranaki* as a stop gap measure, and a force of four frigates was thus maintained until the mid-late 90's when first *Southland* and then *Waikato* reached the end of their service lives.

The second transition began in the late 90's and continued until the PROTECTOR fleet become fully operational in 2010. It could be described as the outcome of a collision between two separate streams of thought concerning defence and security. Following a great deal of public and political controversy, the Palmer Labour government signed a treaty with Australia in 1989 for the supply of two Anzac class frigates with an option for two more to be exercised by 1997. In the event, the Bolger National government allowed the option to lapse, despite the intention to maintain a three-ship naval combat force expressed in the 1997 Defence White Paper and the increasing ages of the last two Leander class frigates, HMNZ Ships *Wellington* and *Canterbury*. Attempts made to re-litigate this decision became academic with the election of the Clark government in 1999, which brought with it a very different view of New Zealand's security needs culminating in Project PROTECTOR, which delivered seven ships with patrol and sealift capabilities. With the commissioning of the final PROTECTOR ship in 2010, the RNZN was left with a heterogenous fleet of 12 ships of seven different classes. That number now stands at 10 ships of six different classes. Even allowing for shortfalls in availability brought about by work force attrition and delays in upgrade programmes, the fact that we have been able to remain viable in the face of such system diversity speaks volumes for the dedication and flexibility of people at all levels of our organisation.

The third transition is upon us, and it brings with it force structure design challenges greater than any in our history to date. Every ship in the current fleet except *Aotearoa* will reach the end of its projected service life in a very short time frame – by some calculations,[6] between 2032 and 2035. In addition, a project is underway to acquire yet another distinctive ship type in the SOPV, and the Defence Capability Plan 2019 (DCP 19) includes a new type of amphibious ship.[7] Both SOPV and the new amphibious ship are projected to reach Initial Operational Release (IOR) before 2029. We are therefore confronted with both unprecedented block obsolescence and the addition of two new ship types to a fleet that many would argue is already diverse beyond the point of sustainability.

This is not an insoluble problem. Rather, it presents us with an opportunity to lift our sights beyond like for like replacement and design an affordable force structure that meets our country's long-term maritime defence needs. Affordability is crucial and extends beyond the acquisition cost of new capability. It includes our ability to sustain our force structure over time so that it remains both available for operations and adapted to evolving strategic and operational needs, and our ability to raise and sustain a viable work force, with all that that entails.

Affordability as a concept warrants further discussion. Fundamentally, it is about how much is paid for a given thing or service, but it is not necessarily achieved by paying the lowest possible acquisition price. Over time, it is more likely to be brought about by sensible strategies that address both acquisition and sustainment, and by sound processes for managing investment in ships and systems over the course of their projected service lives. Above all, an investment decision taken on the grounds of cost that does not deliver the outcome sought by the investment cannot be considered affordable just because it can be achieved within a pre-set fiscal envelope. This principle is applied throughout the New Zealand Defence Capability Management System; whether a given solution will meet the requirement identified in the Strategic Case is tested at key points in the project life cycle. The same principle must be applied to the design of our naval force structure as a whole.

The Opportunity

Our opportunity is enabled by four emerging trends. Three are technological; the fourth derives from new distributed operating concepts and the doctrine being developed to apply them.

The technological opportunities derive from accelerating trends in the development and adoption of open computing architectures; “modularity” in the conceptualisation of ship design; and autonomy. The doctrinal opportunity arises because even very large navies recognise that the cost of traditional multi-function surface combatants makes it impossible to acquire sufficient numbers to address the threats posed by both peer and non-peer competitors; doctrine is being developed to address this reality. Each of these is addressed below.

Open Computing Architectures

The application of digital computing technology to defence problems began in the 1950’s. Early generations of computer-based mission systems were based on hardware and software tailored to a specific purpose, combination of weapons and sensors, and installation. ADAWS (fitted to HMNZS *Southland*) and NAUTIS (fitted to HMNZ Ships *Wellington* and *Canterbury*) represented huge advances over the manual capabilities that they replaced, but over time they become difficult to support and then obsolete because they could not be iteratively upgraded to any meaningful degree. They also had unique user interfaces which required time and practice for operators to become fully proficient. This process had to be repeated when operators were posted to a ship with a different system. Although the NAUTIS system fitted to *Wellington* and *Canterbury* was menu based, operators posted to those ships who were used to the ADAWS system fitted in *Southland* created an ADAWS type manual injection guide to help them adapt.

For some time, naval mission systems such as Combat Management Systems (CMS) have been based on open architecture software. It should be noted that there is a big difference between the terms “open architecture” and “open standards”, and the two are sometimes confused. Systems based on the latter can be maintained and enhanced by the user (such as by the development of specific applications) without reference to the originator of the software, because the standards on which it is based are freely available. Naval systems, whilst now almost invariably open architecture, are generally proprietary, which means that the originator or “owner” controls the means by which they are upgraded and enhanced.

Large navies tend to seek control over software architecture configuration and development, which means having to pay the originator of the software very large sums of money, as the originators not unnaturally seek to recoup the cost of developing the software. Smaller navies like ours are probably better served by licensing agreements which leave software configuration control and development in the hands of the originator, as we are unlikely to be able to afford the in-house software management capability needed to “own” these functions even if we are able to afford access to source code (although a possible alternative is a cost sharing partnership with a larger navy). Regardless of the way in which it is controlled and by whom, an open architecture computing system is designed in such a way that it can be maintained and upgraded over time almost indefinitely. As the software evolves to incorporate new capabilities or address new threats, hardware including processors (based on standard commercial hardware) can be iteratively replaced to provide the greater processing power required by a new software edition, or new functionality. As new weapons and sensors are developed, an open architecture CMS can be integrated with them with relative ease. The RNZN has moved into this era with the Lockheed Martin Canada CMS 330 system being installed in the Anzac class frigates, but the best example is possibly the US Aegis system, which has been in service since the early 1980’s. It will remain in service in the US and several allied navies for the foreseeable future and is being used as the basis for new generations of scalable CMS being designed for new, smaller combatants.

In addition to CMS, open architectures should be applied to other key software defined naval systems, including Integrated Platform Management Systems (IPMS), Integrated Bridge Systems (IBS), and communications control systems, all of which have the same need for ongoing support and development as CMS. Finally, and again crucially, open architecture computing systems can be adapted to a wide range of functions and interfaced with a wide range of physical systems, enabling standardisation across a multi-function fleet. For a navy the size of the RNZN, the advantages thus gained in terms of standardised operator and maintainer interfaces and the rationalisation of supply chains could possibly mean the difference between a fleet (and a work force) that is sustainable in the long term, and one that isn’t.

Modularity

The term modularity often creates confusion because it can be applied on different levels.

A useful definition of these levels was outlined in a RAND Corporation paper released in 2016:[8]

> ***“Common modules used across multiple classes of ships**. These common modules are structural pieces of the ship that are built and tested in a factory-like environment. Although not currently adopted in Navy ship designs, potential applications include hotel-like functions such as galleys, medical facilities, and laundries.*
>
> ***Self-contained modules that provide a plug-and-play capability for the equipment inside the module**. These modules have defined interfaces and boundaries and are designed for a specific task, such as firing a missile. Where common modules can be used across different classes of ships, self-contained modules are typically used within a single class of ships. The vertical launch system (VLS) modules on Arleigh Burke–class destroyers are an example of a self-contained module.*
>
> ***Modular installations that provide a basic ship structure and services that allow various mission packages to be installed and interchanged as needed.** Modular installations, like self-contained modules, have defined interfaces but much broader defined boundaries. The U.S. Navy LCS and the Royal Danish Navy’s Absalon class ships are examples of this type of modularity.”*

In this paper, the term “modularity” is used in the sense that it is used in the third definition above, because as it will hopefully become clear below, that is the level which offers us the greatest opportunity for long term operational viability. However, the second definition above is also relevant, dovetailing with the third. The Mk 41 Vertical Launching System (VLS) fits very neatly with “plug and play” modularity, in that the same basic system is compatible with almost every missile in the US inventory.[9] A ship fitted with Mk 41 VLS can thus be adapted to different missions by altering the missile load out and is adaptable for future missions given that future missiles will be designed for compatibility with Mk 41. If a modular platform fitted with Mk 41 were to be “re-roled” from Anti-Surface Warfare (ASuW) to Anti-Submarine Warfare (ASW) by the installation of the necessary mission modules, the Mk 41 missile loadout could be altered to increase the proportion of ASW weapons, such as the US Anti-Submarine Rocket (ASROC), to that of anti-ship missiles.

Modularity in the sense used in this paper de-couples a ship’s platform and “payload” systems. In this conceptualisation, a ship’s hull and its core systems for propulsion, electrical power generation, accommodation, cooling, communications and navigation are regarded as a fixed backplane to which a removable payload system tailored to a particular mission and level of capability is added. This is not a new concept. The Royal Danish Navy first deployed the STANFLEX modular system in the 1990’s aboard the Flyvefisken class small combatants (54m LOA, 450 tonnes full load). A large, specialised fleet of 20 ships was replaced by 14 that could be adapted (within the limits of their small size) to ASW, Anti-Surface Warfare (ASuW), Mine Counter Measures (MCM) and other roles by the installation of role specific modules. The platforms are almost identical, although some are fitted with a separate hydraulic propulsion system for MCM operations. Modules are designed to connect with standard container positions aboard the platforms and use standard interfaces to connect with platform systems, including the CMS. The Royal Danish Navy has extended the modularity concept to its Absalon class support ships and Iver Huitfield class air defence frigates and plans to replace the Flyesfisken class with new platforms based on the STANFLEX concept.

Without access to protected sources, it is difficult to determine the extent to which the Royal Danish Navy re-roles the Flyvesfisken class by exchanging one set of mission modules for another, although early publicity suggested that this could be carried out in a matter of days. It may be that those ships with hydraulic secondary propulsion systems are permanently equipped for MCM. Regardless of the frequency with which role changes actually occur, the STANFLEX concept enables the management of mission system obsolescence to be separated from that of the core platform. Upgrades of the sort currently underway under the Frigate Systems Upgrade project do not require the entire platform to be taken out of service for lengthy, risky, and expensive open-heart surgery. An upgrade to an ASW module, for example, can be managed within the module, either by upgrading components in the existing module or by replacing it entirely. If an existing module is being upgraded, it can be removed from the ship for the necessary work to be carried out while the ship remains available for operations that do not require that particular module.

Modularity on some level has now been adopted to varying degrees and in various ways by a number of NATO navies, including the Royal Navy with the Type 26 frigate, and the US Navy with the Littoral Combat Ship (LCS).[10] The latter project has been subject to much public criticism, mainly on value for money grounds,[11] but also because the platform design emphasises very high speed at the expense of other important characteristics such as range and seakeeping. Other anticipated gains, including the need for only a very small core ship’s company, have proved illusory in practice. In addition, difficulties and delays have been experienced with mission module technologies, notably the MCM package. Possibly because of the cost of acquiring and maintaining a large number of mission modules many of which would not be in use at any one time, the LCS operating concept no longer features regular mission module and role changeouts – ships will be more or less permanently assigned to a particular mission. However, the challenges that have been experienced with LCS should not be linked to the basic concept of modularity. The advantages described above in relation to obsolescence management and role flexibility achieved by de-coupling a platform from the mission systems it carries very much apply to LCS.

With Type 26, however, core mission systems are not modular in the sense used in this paper, in that they are coupled to the platform in more or less the traditional sense – although increases in ship size and improvements in design no doubt make system replacement much easier than with older, smaller designs such as the Anzac class. Type 26 incorporates a large mission bay capable of accommodating extra helicopters, extra boats, autonomous vehicles, or modules based on Twenty-foot Equivalent Unit (TEU) containers for embarked military forces, medical facilities, and the like. Type 26 is without doubt an extremely capable multi-function combatant, and the mission bay provides significant role flexibility. However, the STANFLEX and LCS concepts in which the core mission systems are modularised are closer to the modularity concept which, in conjunction with open computing architectures, could offer an opportunity for an affordable, sustainable, and credible force structure for the RNZN.

Autonomy

In late 2018, an unmanned 40 metre trimaran named *Sea Hunter* crossed the Pacific from San Diego to Hawaii and returned. The US Navy has requested $579M in funding in FY2021 for the development of three large autonomous vehicles – the Large Unmanned Surface Vehicle, the Medium Unmanned Surface Vehicle, and the Extra Large Unmanned Undersea Vehicle.[12] Other navies have similar programmes, together with plans for the integration of these vehicles with core force structure. Autonomy is about to become a mainstream maritime defence technology for surface and undersea vehicles, as it already is for aerial vehicles.

Autonomous vehicles offer advantages in the maritime space analogous to those offered by the Remotely Piloted Aerial Systems (RPAS) being considered under the New Zealand Defence Enhanced Maritime Awareness Capability (EMAC) project. They can carry an array of sophisticated sensors over very large areas with endurance and operating environment unconstrained by the limits of onboard human operators. Their demand for highly trained operators is not insignificant, but less than that of a manned ship or aircraft. In the case of vehicles operating in an ASW, MCM, or Expeditionary Reconnaissance (ER) role, their deployment does not entail the risk to human life associated with manned platforms.

The legal implications of autonomous weapon systems (particularly those capable of employing lethal force without human oversight beyond pre-mission programming) are being considered by the United Nations, specifically under the aegis of the Convention on Certain Conventional Weapons to which New Zealand is a party. Our adoption of autonomous technology will certainly be subject to international legal frameworks concerning its use. It is equally certain, however, that means of compliance will be found, given the role that autonomy already plays in the defence forces of all liberal democracies.

Autonomy is an excellent fit with modularity. For instance, the LCS MCM capability is based around an autonomous vehicle with supporting containerised equipment. Launch and recovery systems for surface and undersea systems can be standardised, as can the equivalents for aerial vehicles – the vehicles and their support systems are in themselves modules.

New Ways of Operating – Distributed Maritime Operations

Even the largest and most advanced navies in the world are seeking alternatives to ever more expensive multi-function surface warships. The LCS concept was intended to provide the US Navy with the platform numbers needed for operations in the littorals, freeing up cruisers and destroyers for operations where their high-end capability was essential. The Royal Navy has placed orders for five Type 31 frigates, which have been designed to an affordable cost threshold to perform lower end "maritime security" roles, again freeing up more capable and expensive frigates and destroyers for high intensity operations. However, the re-emergence of great power competition in the last 15 years has spurred the development of a new operating concept that could allow the naval forces of small to medium powers to contribute to collective efforts to maintain the rule of law at sea within the bounds of affordability.

Despite the emergence of LCS, Type 31, and other forms of cost driven capability, in the context of growing great power competition the liberal democracies are still faced with the possibility (some would say likelihood) of numerical overmatch, given the rate at which China in particular is expanding its naval fleet and the ways in which "grey zone" operational strategies[13] are extending naval power to paramilitary and ostensibly civilian platforms. A competitor like China can threaten an opponent from a multitude of different directions and in a multitude of different ways across very large areas of operation. Concentrating naval power in a small number of highly capable (and expensive) multi-function platforms simplifies the adversary's surveillance and targeting problem and reduces operational options – even the most capable combatant can only be in one place at a time. Naval thought has therefore turned to ways of operating by which numerical overmatch can be affordably addressed while turning the tables on an adversary.

In 2015, an article appeared in the US Naval Institute *Proceedings* magazine introducing the concept of "distributed lethality".[14] The following quote from that article describes the core concept:

> "…*[Surface Action Groups – SAGs] seize maritime-operations areas for subsequent activities (including power projection), perform screening operations for larger formations, and hold adversary land targets at risk. Additionally, by distributing power across a larger number of more geographically spaced units, adversary targeting is complicated and attack density is diluted…SAGs will be networked and integrated to support complex operations even when not supported by the carrier air wing and land-based patrol aircraft…"*

Distributed lethality was thus about using surface forces more independently and offensively, and about complicating an adversary's sea denial problem by distributing friendly forces over a wide area. Provided there is an evident capability to employ it, distributed lethality thus adds complexity to an adversary's calculations, one of the classic planks of a deterrent strategy.

The authors of the article occupied highly influential positions in relation to naval capability development. At the time it was published, Vice Admiral Rowden was Commander, Naval Surface Forces; Rear Admiral Gumataotao was Commander, Naval Surface Force Atlantic; and Rear Admiral Fanta was Director, Surface Warfare, Office of the Chief of Naval Operations.

Since the article was published, the distributed lethality concept has evolved into a broader, more elaborately articulated concept known as Distributed Maritime Operations (DMO). DMO doctrine is not publicly available, but it has been referred to as a cornerstone of US Navy strategy by successive Chiefs of Naval Operations (CNO).[15]

DMO is described in a paper published by the US Centre for Strategic and Budgetary Assessments (CSBA) as follows:

> *"…DMO seeks to address the limitations of Distributed Lethality by integrating naval forces across domains [space, air, sea, undersea, and land] throughout a theatre to provide targeting and coordinate fires…By combining distribution, decoys, and better defences, DMO would increase the size of an attack needed for an adversary to defeat U.S. naval forces, thereby deterring aggression. It might also require the adversary to take more time to determine the most advantageous way to conduct a smaller attack, thereby delaying aggression…"*[16]

In reading the above, it will occur to the naval practitioner that extolling the virtues of a numerically large force distributed over a wide geographic area is one thing; commanding and controlling such a force in an era where access to the electro-magnetic spectrum for communications will be very difficult to maintain is another. This aspect of the DMO problem has received significant attention. In an article in *Proceedings,* Admiral Scott Swift, US Navy (at the time, Commander US Pacific Fleet) drew attention to the need to distinguish between the art of Command and Control and the actions and technologies used to implement it.[17]

Admiral Swift pointed out that Command and Control is an art practised by Commanders, and that the creation of the Command, Control, Communications and Computing (C4) acronym (and by inference, C4ISR (Intelligence, Surveillance, and Reconnaissance) was unfortunate, in that it conflated Command and Control with the processes and tools by which it is achieved, thus creating an institutional over-dependence on technology and diminishing the US Navy's historical reliance on the skill and initiative of the subordinate.[18] Admiral Swift maintained that undue reliance on systems which allow a Commander to maintain instantaneous contact with an entire force is not only highly problematic given the threats to communications spectrum use, but inconsistent with the principle of mission command.

Admiral Swift acknowledges that addressing this state of affairs is not simply a question of accustoming forces to operating in bandwidth deprived environments and insisting that the principles of mission command be properly applied, although this is very important. In his view, the sheer quantity of data available to the modern CO should drive the development of new tools, potentially based on artificial intelligence, that support the processing of information in a way that enables courses of action to be played out and developed. This could be extended further. Tools capable of assisting course of action development when connectivity is lost could be developed, possibly by projecting forward from the last point at which a CO had access to a complete force picture, allowing for different scenarios to be postulated and evaluated. This view is supported by the following quote from the CSBA paper cited earlier:

> *"…U.S. forces may be unable to sustain high or moderate bandwidth communications over wide areas due to their proximity to adversary jammers and the long distances between U.S. units and theatre commanders. Rather than expend scarce resources to build a new communications architecture to support desired C2 structures, communications requirements could be reduced through an alternative approach to command, control, and communications (C3) that adapts existing C2 structures to*

> *accommodate communications availability. This concept, which could be described as context-centric C3, relies on decision-support tools to help junior commanders develop and execute plans even when communications are lost with senior leaders...”*[19]

It is reasonable to assume that the principles espoused by Admiral Swift will become embedded in the operational practices of the forces with which we are most likely to operate, and that technical and doctrinal means of addressing (if not completely solving) the command and control challenges inherent in DMO will be found. If this does come about, and developments can be monitored as we operate with our partners and take part in exercises like RIMPAC, DMO will become a useful bedrock concept on which to base our force structure.

Coupled with the technological opportunities offered by open computing architectures, modularity, and autonomy, the advent of DMO provides smaller navies with an opportunity for affordable yet valued contributions to multi-national operations that can be sustained over time. To repeat, a key element of DMO is the distribution of capability across a wide area and a large number of platforms. Numbers are important, and therein lies our opportunity. Provided it can defend itself from the most likely threat – anti-ship missiles – while offering capability appropriate to a given mission, a combatant need not be capable across all mission areas in order to be valued, because its very presence complicates the adversary’s calculations. If smaller navies no longer have to invest in combatants permanently equipped with multi-dimensional capability in order to be operationally useful, they might be able to acquire specialised, valued combat capability that they can afford to acquire and sustain over time. Modularity could enable them to field such capability tailored to the specific needs of a given operation.

To approach the problem from a different perspective, the US is investing in 35 LCS platforms, each with specialised modular capability fits, in order to field affordable capability and complicate the adversary’s surveillance and targeting problem. Similarly specialised platforms fielded by a partner nation would likely be valued, provided the navies that operate them are able to conform with DMO doctrinal principles such as those outlined above.

Wider Naval Missions

The narrative above has focussed on the combat capabilities needed for navies like the RNZN to play a role in the preservation of the rule of law at sea. However, the RNZN is required to perform a wide range of other roles related to New Zealand’s wider security interests. It has resources and borders to protect, both New Zealand’s own and those of its Pacific partner nations. It must be able to project special and land forces and support them in operating areas remote from

New Zealand. It has a critical role to play in Humanitarian Assistance and Disaster Relief (HADR), both in New Zealand and in the wider region. It must be capable of search and rescue operations in some of the most challenging maritime environments in the world. Finally, it supports important scientific and conservation work carried out by other government agencies. Although important in and of themselves, these missions collectively contribute to the soft power that is an essential adjunct to combat capabilities in building a secure region. An affordable force structure which addresses all these needs must be designed.

Revisiting Force Structure

Common Modular Platforms

Both combat and patrol platforms need range, endurance, and good seakeeping qualities. In some combat situations, such as choke point escort, speed is a critical tactical characteristic, but patrol platforms also need speed for interdiction and to respond to emergencies. Combatant design needs to consider heat, acoustic, and magnetic signature control and radar cross section reduction to reduce the ranges at which they can be detected and their vulnerability to influence mines, anti-ship missiles and torpedoes. Combatants must also be able to sustain damage and survive, and in some instances, continue to operate. Specialised patrol platforms are much less expensive than combatants partly because their design does not need to take these factors into account.

It may be possible to reconcile differences in the speed and signature control requirements of combatant and patrol missions to enable an affordable single platform to be designed to perform both combat and patrol functions. Modern combatants are typically designed for a maximum sustained speed of around 27kts. Modern offshore patrol vessels are typically capable of 22-24kts. The increase in propulsive power required for a given hull design and displacement to achieve an extra 3-5 kts is significant, but propulsion plants themselves are typically modular, consisting of up to four separate power sources. A combined combatant/patrol platform could operate efficiently in the patrol role by using fewer power sources at any one time to prolong both range and endurance and the time between overhaul periods of the power sources. In many of the areas in which the RNZN operates, the combined hull form could be equally if not more fuel efficient than the smaller hulls optimised for seakeeping typical of patrol vessels, as seakeeping qualities in smaller vessels are generally achieved by using fuller hull forms. Multi-hull designs such as those that Australian shipbuilders are adept at producing may allow seakeeping and speed requirements to be efficiently reconciled in a single platform. Multi-hull and larger mono-hull platforms are also better platforms for helicopters and the unmanned aerial vehicles needed for surveillance coverage and patrol efficiency.

Heat and magnetic signatures can be addressed in ways that are manageable in terms of cost. Acoustic signature control, however, is problematic. Some of the design and engineering features required to reduce radiated noise are highly sophisticated and very expensive, to the extent where it would be uneconomic for every platform in a combined combatant/patrol fleet to be "quieted" to the level of multi-function frigates like the British Type 26 or Franco-Italian FREMM. The impact of this for ASW capability needs to be considered. However, some forms of noise reduction could be affordable across a multi-purpose fleet, including the acoustic isolation of main machinery (raft mounting) and electric drives. These may be sufficient for a multi-purpose platform to be effective using multi-static ASW techniques,[20] particular in relatively noisy and high traffic shallow water conditions.

The potential for combining combat and patrol functions in a single platform able to accept modular systems for combat and/or patrol missions should thus be investigated. If achievable, the advantages in equipment standardisation and thus training, supply chain management, maintenance and upgrade management could be significant. Platform availability could be higher, even with a smaller number of platforms. Flexibility would be enhanced, given that a platform could potentially be re-configured from combat to patrol or HADR missions at short notice, and vice versa. Platform usage rates could be managed so that wear and tear and thus service life is evenly distributed across the fleet. Finally, platform standardisation could provide acquisition and sustainment price leverage on suppliers by enabling a larger scale initial "buy" with the potential for long term sustainment support from original suppliers.

Amphibious Capability

Amphibious sealift is a crucial joint enabler, and limitations in current capability have been identified. In particular, the New Zealand Defence Capability Plan 2019 determined that new capability capable of Logistics Over the Shore (LOTS) operations in higher sea states than those which HMNZS *Canterbury* can cope with is required. Protected mobility is central to New Zealand land force operating concepts, which means that naval amphibious capability should be able to deliver Light Armoured Vehicles (LAV) over the shore. The same applies to the Medium/Heavy Operational Vehicles (MHOV) which are essential to land force capability for both combat and HADR missions. Amphibious capability should also be capable of lifting the considerable quantities of stores, equipment, and ammunition needed by a deployed land force, and there is a strong argument for enhanced onboard medical facilities. Amphibious joint manoeuvre requires rotary wing lift, which requires space and weight consuming hangars and flight decks. Finally, amphibious operations require significant command and control capability, which is expensive in space, computing, and communications capability. These requirements are difficult to reconcile with combat and patrol missions; ships with a very large internal volume and a “well dock” for landing craft operation in typical sea states are needed. However, significant efficiencies could be achieved by specifying the same family of open architecture computing systems and families of equipment across the patrol, combat, and amphibious components of a fleet. It may also be possible to obtain additional price leverage by seeking a single supplier or group of suppliers for the patrol/combatant and amphibious fleet components.

The combined patrol/combatant platform suggested above could still be provided with mission modules that enable a useful degree of complementary amphibious capability. A modular platform could incorporate stern launching systems for Landing Craft Vehicle and Personnel (LCVP) capable of accommodating vehicles (albeit smaller than LAV and MHOV). An embarked military force could use extemporised accommodation and standard accommodation not being used because combat specific modules are not embarked. A platform so configured would be a useful supplement to specialised amphibious platforms, providing Joint Force Commanders with additional manoeuvre options and increasing overall readiness to respond to contingencies, particularly HADR. Our ability to support other government agencies, notably the Department of Conservation offshore islands programmes, would also be enhanced by a greater number of amphibious capable platforms. The stern launching system could be made compatible with boats used for patrol operations (reducing sea state limitations), and with towed array sensors for ASW missions.

Expeditionary Reconnaissance and Mine Counter Measures

Expeditionary Reconnaissance (ER) and Mine Counter Measures (MCM) are essential naval capabilities and are well suited to modularity. Much ER and MCM equipment is already portable or containerised, including autonomous undersea and aerial vehicles. Comprehensive C4 capability is critical to both ER and MCM, and open architecture platform C4 systems provided for patrol/combatant missions could be adapted for these missions. A patrol/combatant with the modular amphibious capability described above would have ample space and accommodation for ER and MCM teams, their capability modules, and their command and control elements. Above all, a modular fleet would mean that any patrol/combatant platform could be adapted for ER and MCM according to need – these capabilities would not be tied to a single specialised platform which may not be available when needed.

Acquisition of a modular combatant/patrol, ER/MCM, and amphibious fleet is a strategy that could be pursued regardless of the level of capability identified to meet policy requirements. Modularity could be pursued within a pre-set cost envelope, with the ratio of investment in numbers of platforms and numbers and types of capability modules determined by policy need. It could also be pursued before such an envelope is identified, with the scale of acquisition adjusted according to capital and operating budget forecasts when these are available. That is why modularity as a force design strategy can be explored without making assumptions about levels of capability and investment.

The Work Force

Modularity offers significant work force advantages, but current approaches to work force management would need to be modified and developed. Each platform would require a core complement for Command, navigation, communications, seamanship, propulsion and generation, logistics, catering, medical support, habitability system operation and maintenance, and damage control. Each module would also require dedicated operators and maintainers, who would embark in platforms with their modules. This is not new to the RNZN. People posted to HMNZS *Matataua* are assigned to HMNZS *Manawanui* (and occasionally other ships) or detached as shore parties with their boats and equipment for discrete ER, MCM, hydrographic or diving missions, returning to *Matataua* on completion. *Matataua* provides them with leadership, administrative and divisional support, and a sense of identity exemplified by their cap tallies. This principle could be extended to ASW, Resource and Border Protection Operations (RBPO), Maritime Interdiction Operations (MIO), air defence and littoral warfare teams, perhaps by the creation of a new establishment along the lines of *Matataua.*

Other issues would need to be resolved, including operating tempo for core complements, the fact that some module crews would be required at sea more than others, and maintaining currency in perishable skills when modules are not installed in ships (simulation is likely to provide a solution), but the outcome could be improved harmony for the work force as a whole, with only those people required for missions in progress being separated from their homes and families.

Replenishment

Aotearoa is nearly ready for commissioning and will provide fleet replenishment and Antarctic re-supply capability for years to come. There are no opportunities for specifying common systems, although these may emerge in time as existing systems wear out or become obsolete.

Bringing the opportunities together

Leaving aside levels of capability, if a fleet re-capitalisation strategy based on modular patrol/combatant/ER/MCM capability and a single common platform, the adoption of open computing architectures, and the standardisation of systems and equipment across ship types were to be considered, it could be possible to reduce the number of platform types in the RNZN fleet from seven (frigates, OPV, SOPV, IPV, *Manawanui* (Dive/Hydro Vessel)*, Canterbury* and *Aotearoa*) to four (patrol/combatants,[21] amphibious sealift, SOPV, and *Aotearoa*) and dramatically improve long term sustainability.

However, a more radical approach consistent with the strategies outlined in this paper but emphasising autonomy could be adopted. Combat, patrol, and amphibious missions could be performed by a single large platform type able to lift and project substantial land forces, but also capable of hosting an array of autonomous air, sea, and sub-sea vehicles for combat, ER, and MCM functions. A through deck design (used for aircraft carriers and large amphibious ships) would simplify the operation of unmanned aerial vehicles and medium utility or naval helicopters, extending combat, patrol, and amphibious capabilities. If large enough, it could accommodate container based ASW, air defence, C2, HADR, ER, and MCM capabilities in a variety of combinations and configurations. It is possible that three such platforms could replace the current combat, patrol, amphibious and Dive/Hydro Vessel platforms, reducing overall fleet platform types to three (three multi-role ships, SOPV, and *Aotearoa*) or possibly four, as there would be merit in retaining the OPV for "right-sized" Pacific engagement. Although they would be large ships, such a fleet might be easier to accommodate in a naval base than the six ships they would replace. Such a concept may seem radical, but the necessary technologies are in place or under high priority development – the US Navy autonomous vehicle initiatives outlined above are germane. Italian industry has already produced a ship with most of the attributes identified above, including a medium calibre gun for support to land forces and a significant air defence capability.[22]

Regional Collaboration

A number of Asian partner navies will face fleet re-capitalisation challenges in a similar time frame as the RNZN, notably Singapore and Malaysia, but potentially also Thailand, Indonesia and the Philippines. International collaboration on naval combatant acquisition does not have an entirely happy history, but if modularity can be exploited to the extent suggested above, it may be possible to set in place a programme for the acquisition of common modular patrol/combatant platforms that each nation can adapt to its own needs. The economic benefits of a programme on this scale for both acquisition and sustainment are obvious. National development objectives for the establishment of indigenous defence and industrial capability could still be satisfied with ships being built in the yards of participating nations (including New Zealand). Such a programme might encourage the creation of a flexible, long term regional defence industrial eco-system that would benefit all partners. Nor would it be necessary to limit participation to Asia-Pacific nations. Many eastern European and South American nations have navies with missions comparable to those of Asia-Pacific and would bring doctrinal and technological expertise t the partnership. The Chilean Navy, with its long history and high international reputation comes to mind. The difficulties with setting such a programme in place should not be underestimated, but nonetheless, the potential exists.

Conclusion

None of the specific points discussed in this paper break new ground. The technologies and doctrine identified are under active development and have been adopted to varying degrees by several of the world's leading navies. Open architectures, modularity and autonomy are being de-risked and the rate at which they are adopted by other navies is likely to accelerate. What this paper has attempted to do is offer ways in which technology and doctrine can be brought together in designing New Zealand's next naval fleet, which other navies with similar missions could also consider.

The RNZN is facing the most significant force structure transition in its history. However, the block service life expiry of almost every ship in the RNZN fleet over a very short time frame gives New Zealand Defence an opportunity to design a naval fleet that in its totality meets New Zealand's maritime defence needs and that is flexible and adaptable over time. Open computing architectures, modularity, autonomous vehicle technology and Distributed Maritime Operations doctrine could be applied to maximise this opportunity regardless of the levels of capability identified by defence policy.

Endnotes

[1] Any errors of fact and any ill-founded deductions in this paper are the author's responsibility. However, a number of people have contributed thinking and perspectives that helped shaped its development. These include fellow naval officers, both serving and retired, in the RN, RAN, RCN, US Navy, Italian Navy, Royal Netherlands Navy, German Navy, Spanish Navy[1] and the RNZN, and a number of defence and security sector civilian officials in these countries. The author is very grateful for the generosity with which officers and officials in the US, Commonwealth, and European NATO countries shared views and insights with him over the course of his time in Capability Branch, HQNZDF, and for the generous hospitality extended to him both at meetings ashore and during visits to ships and shipyards.
Particular mention must be made of Dr Lance Beath, whose invaluable advice has hopefully helped produce a paper that the intended audience finds readable, although as with errors of fact and deduction, any shortcoming in this regard is the author's responsibility.

[2] SOPV will be designed and equipped to operate in the ice, sea state, and temperature conditions typical of the Southern Ocean and Antarctic region, carrying out a wide range of scientific and security missions.

[3] The enormous burden borne by the United States Navy in maintaining the freedom of the seas must be acknowledged. It dwarfs the contribution of every other democratic nation.

[4] Many European and some Asian countries have since established maritime defence industries producing modern naval platforms of every type. In the post war period, choice was effectively limited to ships of US, British, Canadian, or French origin.

[5] On the decommissioning of the last cruiser, HMNZS *Royalist*, in 1966, the Type 12 frigate HMNZS *Blackpool* was acquired on loan from the Royal Navy and returned when *Canterbury* was commissioned.

[6] On the one hand, this estimate assumes service lives for some ships that have yet to subjected to detailed assessment of service life remaining. On the other hand, readers will be aware that some ships in our current fleet are already difficult to maintain.

[7] The exemplar capability used in DCP 19 is the Amphibious Transport Dock, or LPD under the NATO ship designation system.

[8] J Schank, S Savitz, K Munson, B Perkinson, J McGee, J Sollinger; *Designing Adaptable Ships, Modularity and Flexibility in Future Ship designs,* RAND Corporation, Santa Monica, Calif, US, 2016, p xiii.

[9] Noting that different missiles require different launcher peripheral equipment to provide the necessary interfaces between CMS' and missiles in the launcher – not a trivial consideration, but the key point above is valid.

[10] D Manley FRINA, RCNC, UK Ministry of Defence, "The NATO Drive to Mission Modularity", Warship 2018: Procurement of Future Surface Vessels, 11-12 September 2018, London, UK <http://nearyou.imeche.org/docs/default-source/bath-and-bristol-young-member-panel/20180725---mission-modularity-and-nato---rina-20189d3521ea83c06d3085eeff00007c07dd.pdf?sfvrsn=0>.

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[11] And in the writer's opinion, because many people seem to have expected that the LCS would offer capability comparable to a traditional multi-function frigate, when this was never part of the original concept.

[12] *Navy Force Structure and Shipbuilding Plans: Background and Issues for Congress*; Congressional Research Service, April 13, 2020; p 3.

[13] "The grey-zone is a metaphorical state of being between war and peace, where an aggressor aims to reap either political or territorial gains associated with overt military aggression without crossing the threshold of open warfare with a powerful adversary. The 'zone' essentially represents an operating environment in which aggressors use ambiguity and leverage non-attribution to achieve strategic objectives while limiting counteractions by other nation states." A Singh; *Between War and Peace: Grey-Zone Operations in Asia*; Australian Institute of International Affairs, 13 Feb 2018 <http://www.internationalaffairs.org.au/australianoutlook/paramilitaries-grey-zone-operations-asia/>.

[14] Vice Admiral T Rowden, Rear Admiral P Gumataotao, and Rear Admiral P Fanta, USN, *Distributed Lethality,* United States Naval Institute *Proceedings*, January 2015.

[15] *A Design for Maintaining Maritime Superiority Version 2.0,* issued under the signature of Admiral J Greenert, USN, Chief of Naval Operations, December 2018; FRAGO 01/2019, *A Design for Maintaining Maritime Superiority Version 2.0,* issued under the signature of Admiral M Gilday, USN, Chief of Naval Operations, December 2019.

[16] B Clark and T Walton, *Taking Back the Seas – Transforming the US Surface Fleet for Decision Centric Warfare;* Centre for Strategic and Budgetary Assessments, Washington, USA <https://csbaonline.org/uploads/documents/CSBA8192_(Taking_Back_the_Seas)_WEB.pdf>.

[17] Admiral S Swift, USN, *Master the Art of Command and Control,* United States Naval Institute *Proceedings,* February 2018.

[18] To explain further, Intelligence is an outcome of a process of information analysis; Surveillance and Reconnaissance are activities that collect the data on which this analysis is based. Computing and Communications are technical means of exchanging, processing and presenting the information which enables Command and Control.

[19] Clark and Walton, *Taking Back the Seas – Transforming the US Surface Fleet for Decision Centric Warfare,* p ii.

[20] Multi-static sensing involves the use of distributed active and passive sensors. For example, a ship could tow an active sonar source, whose transmission could enable submarines to be detected using a passive towed array or a sonobuoy field deployed by helicopter.

[21] ER and MCM capable.

[22] The ship was delivered to the Algerian Navy in 2014. It is a development of the Italian Navy's San Giorgio class.